Abstact of the paper

"**A New Load Shedding System for Industrial Loads in the Italian Power System"**
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Interruptible Customers must satisfy GRTN (Independent System Operator) requirements. Some of these requirements are:

- to be a final user, so that the responsibility of the consequences of the load shedding can be directly attributed to the customer;
- to be users supplied by the high voltage network;
- to have a shedding power above a certain limit;
- to select and describe loads relating to the assigned bands, as an Interruptible Customer can shed loads both in *real time* (without notice) and *upon notice* (15 minutes);
- to guarantee a continuous service of the LSPU (*Load Shedding Peripheral Unit*) apparatus, and of the router connected to it;
- to guarantee there are no timers, by-pass circuits, relays, programmable logic controllers between the LSPU apparatus and the interruptible circuit;
- to create a blocking circuit upon re-closure by GRTN, and to present suitable pre-settings to assure the
- redundancy of the opening commands received;
- to guarantee security for people, equipment and productive processes, releasing GRTN from any civil and criminal responsibility as regards damages to things or people due to the load shedding.

2.1. Control and Data Acquisition Network

The Control and Data Acquisition Network of the IMC system, (or *Communications Network)* was designed in order to obtain high performance levels especially for the *real time* function.
Two separate communication systems were made:
- a WAN (*Wide Area Network*), created by using a *Frame-Relay* technology with two 64 kbps PVCs (*Permanent Virtual Unit*) between the two routers installed at the National Control Centre (NCC) and the two routers installed in each of GRTN's seven Area Control Centres (ACCs). In order to guarantee redundancy and to offset possible *fail-overs*, the pair of routers in each station have been configured in a redundancy mode (HSRP), while a market standard configuration (EIGRP) has been implemented as routing protocol;
- a pair of PVC circuits (one 9.6 kb PVC featuring an ISDN-type backup) installed in each of GRTN's ACCs, to connect the WAN network to the LSPU devices of the interruptible plants in the area run by that each ACC. This allows each Interruptible Customer, in charge of these connections, to competitively choose a standard network service supplied by any national telephone Provider.

Data exchange modes are IEC 870-5-104, on TCP/IP support, with a specifically customised profile.

2.2. General Architecture of the IMC system

The processing unit of the IMC system consists of two computers acting as *servers* in *master-hot standby* configuration, to guarantee maximum operating continuity, and is located in a protected site inside the NCC. Servers act as an interface towards external devices (*front-end*) and also carry out the specific applications of the IMC (Interruptibles Management Consolle) system. Moreover, they are connected to the remote consoles at the ACCs and to the consoles (*clients*) installed at the NCC.

The system also includes LSPU devices installed in the plants of the Interruptible Customers. Their function is to measure, in real time, the power load, as well as other auxiliary information and to activate the shedding command following an order proceeding from the responsible ACC or from the GRTN NCC.

Finally, in case of load shedding request, the IMC system sends the NCC's EMS system a signal to block the Load-Frequency Control in the electric area involved by the load shedding. This is done to prevent the load-frequency regulator from acting on Italian production units to bring the imported power level back to the programmed level prior to the load shedding, hence thwarting the reduction of overload of the international tie-lines. The blocking signal is sent from the IMC system to the Load Frequency Control system through a firewall-protected connection.

2.3. The IMC system's software

Communications with LSPU devices are managed through a custom made driver, interfacing with a server based on a standard format for data exchange (*Ole for Process Control* - OPC) in a Microsoft environment, and based on standard telecontrol interface IEC 870-5-104. The OPC software layer provides data to a SCADA software, acquired on the market. Plus, in order to specialise the SCADA software for particular functions required by the IMC system, it was necessary to implement new *scripts* in the programming C++ language .

Several functions are emphasised, including the MMI module with which the dispatchers operate the interruptible function. The software was designed in order to guarantee straightforward and intuitive use and visualisation of the control actions' efficiency, by showing an updated measure of each single load connected to the virtual shedding button.

2.4. The IMC-Web

The IMC-Web (BMI-Web in Italian) advanced web interface was created in order to simplify the display of, and the access to, IMC generated data as well their database storage.
The interface provides both analysts and management with a common online tool, as well as access to:
• IMC retrieving historical data
• LSPU status
• Real time data of power available to be shed with dynamic coloration (green: normal status, red: shed, yellow: alert status). The IMCWeb program stores IMC generated data (currently at 5 minute intervals) in a database and provides preformatted report templates for retrieving stored data.

The software platform relies on a Linux operating system, MySql database and Php scripting language.

Web server, in case of load shedding or alert, manage automatically to send. a selected list of GRTN experts and managers, e-mails and SMS messages to mobile reporting synthetically: the shed areas, the shed load amount, date and hour of the control action.

2.4. Presetting of the Interruptible Installations

It has already been pointed out that in all interruptible installations the shedding action is managed by a device called LSPU. This device consists of:
- an interface with the Communication Network (router);
- an RTU device;
- a terminal board for connections to the customer's apparatus. This terminal board is sealed by GRTN when the connection with the IMC system is activated, at the presence of the Certifying Agency's representatives;
- an active power transducer.

The data exchanged between the LSPU device and the interruptible installations are the following:
- measurement of active power every 4 seconds, so as to allow GRTN to take note of the interruptible power almost in real time;
- position (on/off) of the interruptible load breaker, to allow to record the occurred cut-off;
- open command of the interruptible load breaker and block any reclosing attempt;
- unblock local reclose command.

GRTN asked each Interruptible Customers to install, test and maintain of LSPU devices, under their own responsibility.

The shedding command, given by the LSPU device, acts directly on the tripping coil of the breaker of the circuit that supplies the interruptible load. With this configuration, the elapsed time between command and shedding is the lowest possible. Besides, the shedding command also holds the breaker on the *off* position until the release command is received, which allows to turn it back to *on*. This solution was chosen in order to prevent unintentional local reclosing action because of personnel safety.

As regards the *upon notice* interruptible function, the LSPU device provides the terminal board interfacing with the interruptible installation with a command of load reduction, which can be sent, at the discretion of the Interruptible Customer:

- to a control system, in order to reduce the interruptible load within 15 minutes;
- to any signalling device, for example, an alarm, which gives the Interruptible Customer a notice of the load reduction command.

Instead of the breaker position signal, one of the two above mentioned devices will return the LSPU apparatus the signal of ascertained reduction, which will be successively confirmed by the actual fall in the power absorbed to be seen through the IMC system interface.